The Visible Human Dataset for the simulation of the cardiac electrical activity propagation

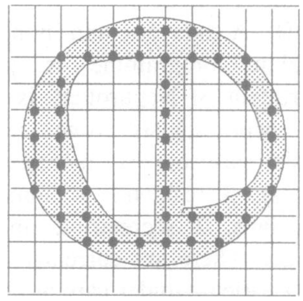
Paolo Valenza[a], Francesco Pinciroli[bc]
[a]Dottorato di Ricerca in Ingegneria Elettrotecnica of the Politecnico di Milano, Italy, [b]Dipartimento di Bioingegneria of the Politecnico di Milano, Italy, [c]Centro di Teoria dei Sistemi of the CNR, Milano, Italy

The Visible Human Project [1]is aimed at the acquisition of transverse CT, MRI and cryosection images of a representative male and female cadaver at an average of one millimeter intervals. Images, divided by anatomical area, are stored as:

- color photographs: 2048 x 1216 pixels, 24 bit per pixel
- CT scans: 512 x 512 pixels, 16 bit per pixel
- MRI scans: 256 x 256 pixels, 16 bit per pixel

Part of the Visible Human Dataset (VHD), the male virtual cadaver, is now available via the Internet .

Many investigators are working on the simulation of the cardiac electrical activity propagation, but only a few consider the heart as a whole[2][3]. We are working on simulation of the activity of the whole heart, both atria and ventricles. The aim is to simulate such activity in various conditions and verify results locally in the heart itself. The study of local behavior requires an accurate description of the whole heart structure. One approach to this problem is the use of cellular automata[4]. The heart is modelled as a network of nodes, each one characterized either by a finite number of possible states and by a variable number of neighbors (12 maximum). A few rules iteratively applied to each node of the network determine the dynamic.
The description of hearth anatomy has to be as accurate as possible. A particular attention is directed to the input of parameters required for the simulation. Network topology is a two step procedure: definition of network geometry and attribution of physiologic parameters to nodes in order to describe electrical behavior in each zone of the myocardium.
The thorax area of the VHD may be used for the first step. Color photographs offer the higher resolution: each pixel is 0.33mm x 0.33 mm. The network representing the whole heart may be obtained matching a grid of nodes and 3D image from the VHD. As an example, the procedure for a bidimensional slice of the heart is shown below.



The second step requires manual attribution of a type to nodes representing cardiac cells of the same class. It is possible to edit existing or create new types to simulate cell abnormalities. Each node need attribution of a type, representing its electrical parameters. The user can modify electrical parameter of each node.
The results of each simulation are temporal sequences of 3D maps of potentials (potential in each node, in each instant). Their visualization requires ad hoc modalities to allow various way to analyze results.

References

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3) Wei D., Okazaki O., Harumi K., *Influence of Myocardial Anisotropy on Global Excitation Sequence of the Hearth and Body Surface Electrocardiogram: A Simulation Study*, 1993, Proc. of Computers in Cardiology, 249-252
4) Saxberg B.E.H., Cohen R.J., *Cellular Automata Models of Cardiac Conduction*, In Glass L., Hunter P., McCulloch A. editors, Theory of the Hearth, Springer-Verlag, 1991, pages 438-476